CIRCULAR No. 295 DECEMBER 1933
UNITED STATES DEPARTMENT OF AGRICULTURE
WASHINGTON, D.C.

THE OBSCURE SCALE ON THE PECAN AND ITS CONTROL

By HOWARD BAKER,[1] *assistant entomologist, Division of Fruit and Shade Tree Insects, Bureau of Entomology*

CONTENTS

INTRODUCTION

Because of the prevalence of the obscure scale in Louisiana pecan orchards, the increasing demands for recommendations for its control, and the wide variation in the control measures that have been recommended, a study of its biology and control was made from 1929 to 1932, inclusive, at the pecan insect laboratory of the United States Bureau of Entomology at Shreveport, La. The results of these investigations are reported briefly in this circular.

The obscure scale (*Chrysomphalus obscurus* Comst.)[2] was first described in 1880 by Comstock (*2, p. 303*),[3] when he found it attacking the willow oak (*Quercus phellos*) in the District of Columbia, and was first reported as a pest of the pecan by Herrick and Harned in 1909 (*6*), when they found it attacking the pecan in Mississippi. This scale is probably a native pest, as it has not been reported from any foreign country. It has now been reported from nearly all of the territory from Massachusetts south to and including Florida and west to include Illinois, Kansas, Oklahoma, and Texas (fig. 1). It is usually found on oaks and hickories but is occasionally found on other plants. The pecan is a favorite host plant, and this scale insect is a serious pest on both seedling and improved varieties in Texas, Louisiana, Arkansas, Mississippi, and Alabama. It formerly attracted only occasional notice, but, with the increasing importance of the pecan industry, it has lately come into more prominence.

In general, the measures recommended for its control have been those which have proved satisfactory for related scale insects, but in many instances they have been inadequate. Most writers (*5, 7, 9*) have quite generally agreed that lime-sulphur, at whatever

[1] The author expresses his appreciation of helpful suggestions received from G. F. Moznette of the pecan insect laboratory of the U.S. Bureau of Entomology at Albany, Ga.

[2] Order Homoptera, family Coccidae, subfamily Diaspinae.

[3] Italic numbers in parentheses refer to Literature Cited, p. 19.

strength, will fail to give control. Recommendations for the use of oil sprays have varied widely, miscible oil sprays being generally recommended for use at a dilution of 1 part stock solution to 15 parts water (*7*), whereas oil emulsions have been recommended for use at strengths ranging from 2 to approximately 11 percent oil in the diluted emulsion (*3, 4, 5, 9*).

NATURE OF INJURY

The obscure scale attacks all parts of the tree proper and in cases of severe infestation has been found on leaf and leaflet stems, but never on the leaves themselves or on the nuts. As there is but one generation a year this scale must, for self-preservation, develop on those parts of the tree which remain alive the entire year, for it can not live on dead plant tissue.

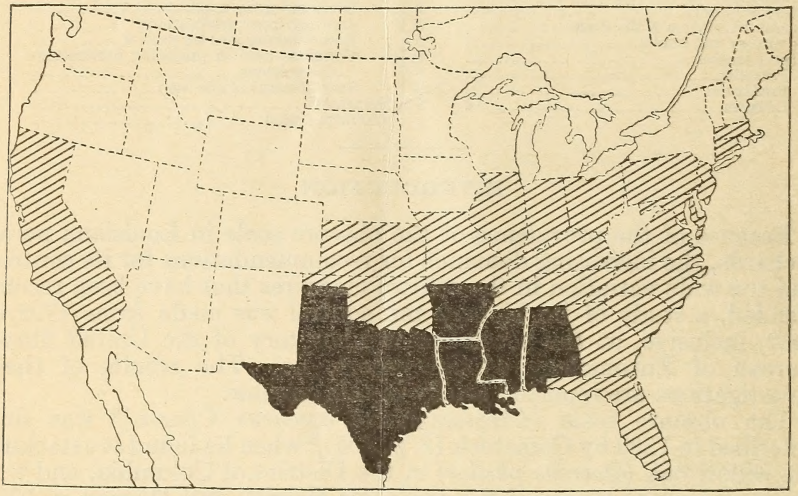

FIGURE 1.—Map of the United States showing the distribution of the obscure scale (*Chrysomphalus obscurus*). The black area indicates those States in which it is an important pecan pest and the cross-lined area indicates additional States in which it has been found.

The initial infestation commonly starts in slight depressions in the bark surface or about the buds. The scale tends strongly to develop at first on the lower, inner portions of the tree, the infestation building up gradually until the parts first attacked are completely encrusted, while it spreads slowly and gradually toward the terminal portion of infested branches. A badly infested branch will usually be killed before much of an infestation has been built up on its terminal portion. Very few trees have been noted on which all parts have been attacked alike. More often the incrustation is heavy on one or more of the main leaders and their branches, or one side of the tree, whereas the remainder of the tree shows only a slight infestation. The examination of a number of moderately infested felled trees has shown that little or no scale develops in the upper third of them. On small to moderate-sized heavily infested trees the scale infestation reaches more nearly to the top. The general appearance of the scale mass on an infested tree or branch is that of a roughened deposit on the surface of the bark (fig. 2).

Attack by this insect results in the gradual killing of branches. Those most commonly killed range in size from the smallest up to those approximately 3 inches in diameter. Branches thicker than 3 inches are seldom killed, though they may be weakened to such an extent that they will not produce normally if at all. The slow progressive killing of infested branches gradually reduces the number of fruiting limbs, besides weakening the whole tree and rendering it more subject to attack by borers or other insects, and diseases. Trees lacking proper fertilization, cultivation, and care are the most often seriously infested, but many trees in well-cared-for orchards have also been found seriously infested.

GENERAL DESCRIPTION OF THE STAGES

The entire life of this scale insect, except the brief presettling, or crawler, stage and the short active life of the adult male, is spent

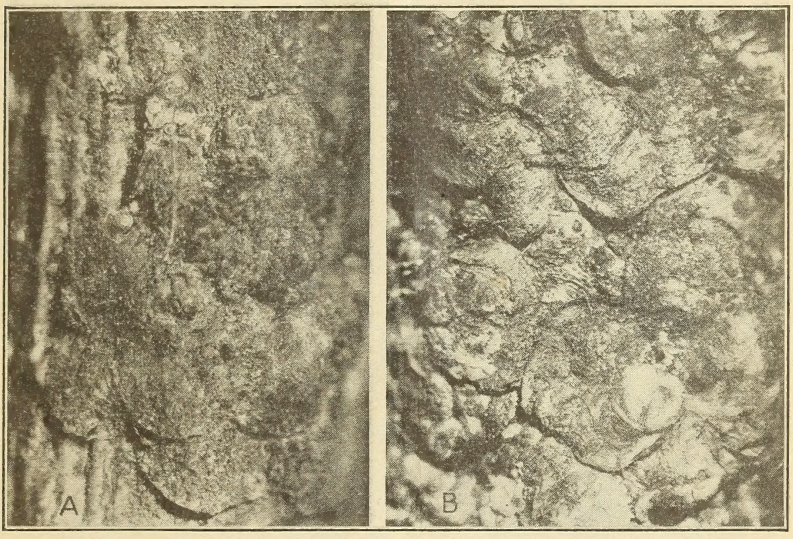

FIGURE 2.—Appearance of an infestation of the obscure scale on pecan: *A*, A partly encrusted infestation; *B*, a completely encrusted infestation. × 8.

beneath the protection of a waxy scale covering. At all other times the insect is concealed and cannot be seen without first removing the scale covering.

The eggs are ellipsoidal, about 0.25 mm long, light purple to lavender, and frequently have a whitish bloom.

The young, or crawlers, appear as tiny indistinct specks moving over the surface of the bark. They are oval and pale salmon-pink, save for the tiny orange-colored rear end, or pygidium. The pygidium retains its orange color through all of the stages in which it is present. After finding a place to settle, the young insects begin to secrete scales which are at first white and circular, but soon become slightly longer than broad, and gradually take on the coloration of the surface on which they rest (fig. 3). The first-stage larvae beneath the covers soon become silvery with a pink tinge, but are otherwise like the crawlers save for their gradually increasing size.

The second-stage larvae have no appendages except their mouth parts; and their bodies, which are but slightly longer than broad, narrow somewhat posteriorly, and are pale yellow. The males can first be distinguished from the females about the middle of the second stage, when they become more elongate and pink, and develop two pairs of rudimentary eyes.

The adult females are slightly wrinkled and still pale yellow until the developing egg mass within the body gives them a purple appearance. When full grown they are but slightly longer than broad, being about 1.25 mm long by 1.20 mm wide. As the time for egg extrusion nears, the last body segment is drawn up so that the body is about four fifths as long as broad (fig. 4, *A*, *c*).

The male propupae have no mouth parts or pygidia but retain their coal-black rudimentary eyes, regain the rudimentary antennae and

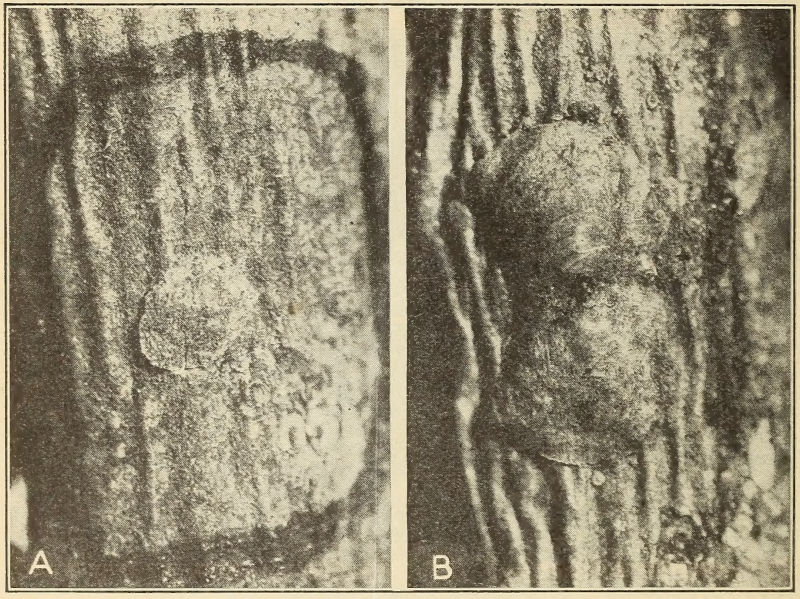

FIGURE 3.—The obscure scale on pecan bark: *A*, A single male scale specimen; *B*, two female scales. × 8.

legs, and develop wing pads. They are salmon-pink, oval, and slightly less than 1 mm long.

The pupae are like the propupae in size and shape, their antennae, wing pads, and legs are further developed, and a prominent protuberance, or anal style, is present at the rear end for the first time.

The adult males are tiny, frail, salmon-pink to brick-red, flylike insects with a mahogany-colored band across the thorax and a long anal style.

The covers of adult females are slightly convex, somewhat irregular in outline, slightly longer than broad, and about 3 mm (about one eighth inch) in length. They blend in color with that of the bark surface on which they rest, being of varying shades of gray to black, and have a prominent lip at the rear end when full grown (figs. 3, *B*, and 4, *A*).

The covers of the males are nearly oval and slightly over half as large as those of the females. They blend in color with that of the surface on which they rest, and if viewed ventrally, show two white longitudinal ridges, one along each side of the body of the developing male (fig. 4, *B*).

LIFE HISTORY AND HABITS

The eggs are formed within the body of the female and can first be seen about the first of April. As they become fully developed, they are pushed out by the female a few at a time and partly fill the cavity left beneath the scale cover by the retraction of the last body segment of the female. The first eggs are usually found extruded between the middle of May and early June, and the first young, or crawlers, can be found a few days later. Both eggs and crawlers are present in large numbers throughout June and until the middle of

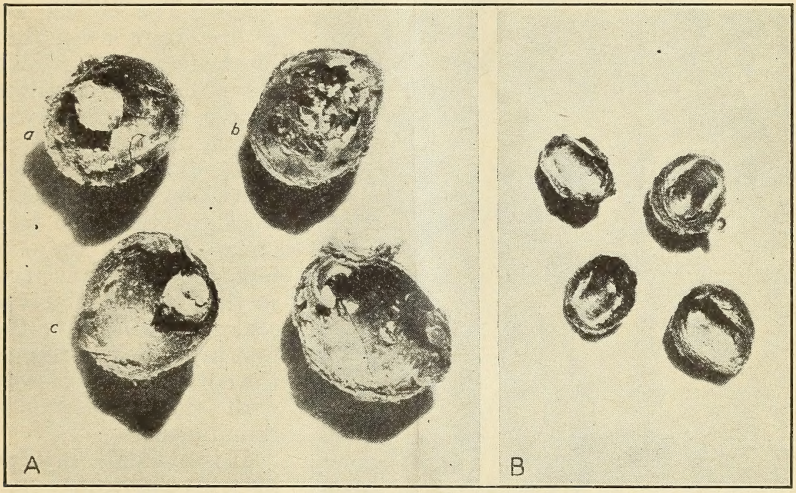

FIGURE 4.—Ventral views of the obscure scale: *A*, Female scale covers showing the lip at the posterior end, the molted skins in *a* and *c*, and the retracted shrunken body of an adult female in *b*, × 6; *B*, male covers showing the white longitudinal ridges, × 6.

July, after which they gradually decrease in numbers until by the first of August but few remain. Scattered specimens may be found until late in September or early in October. Data indicate that each female may produce about 150 eggs and that, under favorable conditions, slightly over 100 of these will develop into crawlers that settle.

The crawlers may settle beneath the cover of the parent or other old scale, or in the open on some other portion of the host. The first newly settled young are always found beneath old scale covers. Those that go outside settle within a few hours and usually not far from the parent scale. Data obtained in January and early February 1931, representing nearly 30,000 specimens from three Shreveport orchards, showed that 84.44 percent of the live specimens were females and 15.56 percent were males. Of the live females 62.63 percent were settled under old scale covers and 37.37 percent were outside, while only 5.72 percent of the males were settled under old scale covers. These

data are valuable from the standpoint of control and may explain, in part at least, the wide variation in the recommendations which have been made for the use of oil emulsions in controlling this insect; for experiments have shown that it is difficult to obtain a complete control of that portion settled under old scale covers, especially in encrusted infestations. Consequently, the higher the percentage of specimens developing under old scale covers, or the older and heavier the infestation, the heavier the concentration of oil likely to be needed in the spray solution to effect a satisfactory control.

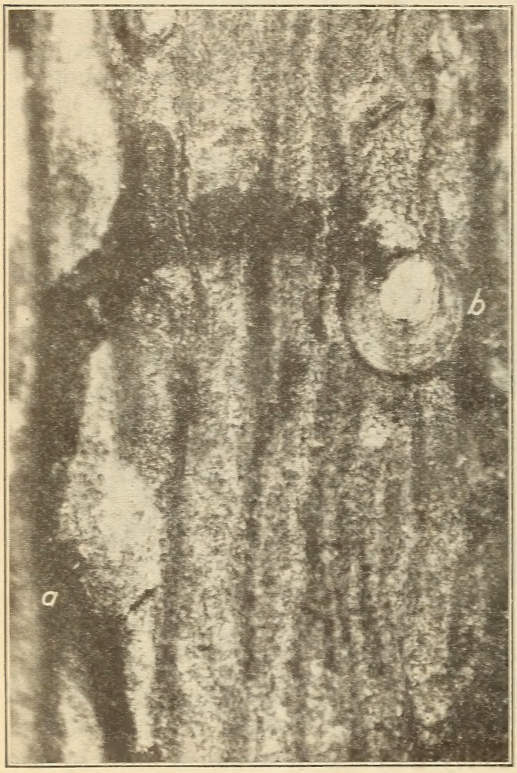

FIGURE 5.—Two immature individuals of the obscure scale which settled on or near a line made with black india ink: *a*, Specimen left in place showing a portion of it in contact with the black line; *b*, specimen removed showing the portion of the line gone where it was formerly covered by the scale cover. × 20.

The newly settled young begin almost immediately to form their covers, and by the end of 6 to 8 hours these are usually sufficiently developed to conceal them. The covers are at first pure white, but by the end of the second day after their formation they become light brown; by the end of the first week, dark brown; and by the end of the second week they begin to take on the color of the surface on which they rest, so that by the time the scales are ready for the first molt the coloring of the covers blends closely with that of the surroundings.

It is evident that this insect is able to incorporate into its cover some portion of the surface on which it develops, for the color of its cover always blends with it. Figure 5 shows where two specimens settled on or near a black india-ink line, one of which, at *a*, has not been touched, while the other, at *b*, has been removed. It is to be noted that that portion of the cover of the specimen at *a* which is in contact with the black line is black while the remainder of the cover blends with the bark on which it rests. That the line was actually incorporated into the cover is evident from an examination of the place from which the specimen at *b* has been removed, which shows the line to be missing where it was crossed by the removed cover and to be intact beyond what was the outer margin of the cover. This would seem to indicate quite clearly that the insect is able to utilize the surface of the bark on

which it settles in the formation of its cover and by this use blend itself into the coloration of the surrounding bark surface. In figure 6 is shown the light appearance of the scale covers on a light-colored bark.

The first molt begins about 5 to 6 weeks after settlement, and second-stage larvae appear about 1 week later. By the middle of September practically all normally developing specimens (about 50 to 60 percent of all that settle) have reached this stage. No other change in development is to be noted save for a gradual increase in size until

FIGURE 6.—A group of individuals of the obscure scale on a very light-colored bark. Compare these with the scales shown in figure 2. × 12.

about the middle of October, when some of the males can be distinguished from the females for the first time. From this point development of the two sexes proceeds along different lines.

The females continue to increase in size until about the first of December, when the older ones begin to enter the stage preparatory to the second molt, followed shortly by the remainder, with practically all specimens completing the change by the last of January. The females remain in this stage until development into the adult stage

is started—usually some time between the middle and last of February. The second molt is usually completed and the first adult females noted about 2 weeks after development is resumed, or between the first and middle of March, and by the middle of April practically all normally developing females have reached the adult stage.

The males, which can first be distinguished from the females about the middle of October, continue differentiation from then until, by the middle of November, practically all of them can be distinguished. The males begin transformation to the propupal stage the last of January and to the pupal stage in late February or early March, reaching the adult stage at about the same time that the females are undergoing the final change to adult, or some time in late March or early April. The height of the male emergence period has ranged from the middle of March to the middle of April. Although provided with wings, the males are not strong fliers, and their active life is short—only a day or two at the most. They have been observed fertilizing females shortly after their emergence, frequently visiting one after another in rapid succession.

Eggs may be observed forming within the bodies of the females shortly after fertilization, or, usually, some time during the first half of April. Thus the life history from egg to egg shows this insect to develop only one generation each year.

Limbs infested with the obscure scale have been collected from time to time in orchards both north and south of Shreveport. These samples have been examined so that the stage of development of the scale specimens on them might be compared with that of specimens collected in Shreveport orchards at the same time. The variations found have not been great—2 weeks' difference in development being about the greatest that has been found. These data indicate clearly that this insect has only a single generation each year throughout its present known range.

NATURAL CONTROL

Parasites, predators, and diseases, the common natural-control agencies, exert an important influence upon the number of specimens of the obscure scale which are able to develop from crawler to adult. It is difficult to arrive at an accurate estimate of the benefit derived from these agencies, because of the long period through the year in which they work, and because by the end of the year many of the earlier-attacked specimens are destroyed by scavengers, drop off, or are so frayed that they cannot be distinguished from material similarly affected in previous years.

PARASITES

Four minute, wasplike parasites have been reared in numbers sufficient to indicate their importance in the natural control of the obscure scale. These species, in the order of their importance, are *Prospaltella fuscipennis* Gir., *P. berlesii* How., *Physcus varicornis* How., and *Ablerus clisiocampae* Ashm.[4] In addition to the species listed, one or a few specimens of additional probable parasites have been reared but not in sufficient numbers to indicate that they are of importance. Data show that parasites destroyed about 14 percent of the obscure scale during the 1931 season and about 21 percent during the 1932 season

[4] Determined by A. B. Gahan of the Bureau of Entomology.

in two Shreveport orchards. Less complete data from other orchards indicate that the above percentages give a fair idea of the numbers of parasites usually present. Naturally, these numbers vary somewhat from orchard to orchard and from year to year.

PREDATORS

Predators exert their greatest influence during the period of egg and crawler development. The coccinellids, or lady beetles, which are important predators of other scale insects, are unimportant in connection with the obscure scale so far as has been observed.

Mites, several species of which are present in considerable numbers at most seasons of the year, are largely scavengers, destroying old dead scales, but four species of mites have been observed to attack live individuals of the obscure scale. Specimens of *Cheletia* sp., *Atomus* sp., and *Allothrombium* sp.[5] have been observed in a few rare instances to attack crawlers after they have emerged from beneath the parent scale cover but before they have settled. They are relatively unimportant predators. A fourth mite, *Hemisarcoptes* sp.[5], is an important predator as well as a scavenger. Examinations over a 3-year period of 600 females of the obscure scale shortly after they completed reproduction showed them to contain an average of 15.93 unextruded eggs and to have an average of 20.03 unhatched extruded eggs plus dead unsettled crawlers remaining beneath their scale covers. The last-mentioned mite is responsible for a portion of these remaining eggs and dead crawlers, as it attacks reproducing females, causing their premature death and consequent failure to finish the extrusion of their eggs. It also attacks the extruded unhatched eggs and newly hatched crawlers before they emerge from beneath the parent scale's cover. This mite has not been found in any numbers until after the egg-extrusion, crawler-emergence period is well advanced. Examinations of scale-infested material late in the season have shown nearly 100 percent of the producing females on some samples to be attacked by this species. Although this mite arrives too late to prevent a large portion of the crawlers from settling, it does arrive in time to destroy a portion of them and to cut short the reproduction.

DISEASES

Diseases, like parasites, are an important natural means of control of this scale insect. Two diseases have been found attacking the obscure scale, namely, *Myriangium duriaei* Mont. and Berk. and *Sphaerostilbe aurantii-cola* (B. and Br.) Petch.[6] Because these diseases occur over such a long portion of the year, it is not possible to make an accurate estimate of their work, but some idea of their value may be ascertained when it is considered that, with the help of parasites, they are apparently holding this scale in check in some southern Louisiana pecan orchards in which artificial control measures are not being practiced. Although diseases may attack newly settled specimens as early as August and older specimens as late as June of the following year, their greatest development takes place during the winter and early spring. The examination of 29,714 specimens from three Shreveport orchards in January and early February 1931

[5] Determined by H. E. Ewing of the Bureau of Entomology.
[6] Determined by Vera K. Charles, of the Bureau of Plant Industry.

showed 3,946, or 13.28 percent of them, to be affected by disease. An examination of scale-infested material from almost any southern Louisiana pecan orchard at this same period of the year would show a much greater percentage diseased.

ARTIFICIAL CONTROL

While parasites, predators, and diseases do their share in holding this scale insect in check, they cannot be depended upon to do so always or as effectively as is necessary. Consequently, it is necessary to develop some method of artificial control which can be depended on in time of need.

DORMANT SPRAY APPLICATIONS

During the last 3 years lubricating-oil emulsions, miscible oils, and liquid lime-sulphur have been tested at a number of strengths and applied at different times during the dormant period and at the delayed-dormant period.

Preliminary experiments were carried out in two orchards early in 1930, the results of which indicated that (1) the obscure scale is difficult to control effectively, (2) liquid lime-sulphur, even at a dilution of 1 part of stock solution to 5 parts of water, and lubricating-oil emulsions containing 2 percent of oil in the diluted spray are ineffective, giving practically no control, and (3) miscible oils, 1 part stock solution to 15 parts water, and lubricating-oil emulsions containing 4 and 6 percent of oil in the diluted spray can be depended upon to give a fair to moderate degree of, but not perfect, control.

During the dormant season of 1930-31, lubricating-oil emulsions, miscible oils, and liquid lime-sulphur were tested again. Three oils of widely different characteristics were emulsified by two formulas and applied at concentrations of 2, 4, and 6 percent of oil in the diluted emulsion at three widely separated times during the dormant period in two different orchards. Two miscible oils were tested at a dilution of 1 part stock solution to 15 parts water, and liquid lime-sulphur testing 34° Baume was used at a dilution of 1 part stock solution to 7 parts water. The results of these experiments are given in table 1.

The results shown in table 1 indicate that (1) lubricating oils at equivalent dilutions are about equally effective whether emulsified according to formula 1 or formula 2, (p. 17); (2) about the same degree of control may be expected from spraying at anytime during the dormant season; (3) the characteristics of the oils used did not appear to influence the degree of control, indicating that any of the oils falling within the range of those ordinarily recommended for use in dormant spray work (8) [1] should be about equally effective; (4) 2-percent lubricating-oil emulsions are ineffective, not even giving a good control of the exposed scales; (5) 4-percent lubricating-oil emulsions are fairly effective, giving a good control of the exposed scales and a fair control of those developing under old scale covers; (6) 6-percent lubricating-oil emulsions are reasonably effective, giving a good degree of control of the scales developing under old scale covers as well as of the exposed scales. The control effected by this dilution can be considered commercially satisfactory, since this scale has only one

[1] Range of specifications ordinarily recommended for oils for use in dormant sprays: Viscosity (Saybolt 100° F.), 90 to about 200 seconds; volatility, low; unsulphonated residue, not less than 80 percent.

generation each year, and the numbers are further considerably reduced by natural agencies; (7) miscible oils varied widely in effectiveness, giving generally poorer results than the 4-percent lubricating-oil emulsions but considerably better results than those given by the 2-percent emulsions. While far from satisfactory, they will, with the assistance of natural agencies of control, hold a scale infestation in check; (8) liquid lime-sulphur was not effective.

TABLE 1.—*Results of spray experiments on the obscure scale on pecan trees, Shreveport, La., 1930–31*

[Approximately 1,000 scales were examined in each test except no. 22, in which approximately 3,000 scales were examined]

Test no.	Material used [1]	Oil percentage or parts of stock solution to parts of water	Spray applied December 1930				Spray applied February 1931				Spray applied March–April 1931			
			Scales dead				Scales dead				Scales dead			
			Exposed scales	Scales settled under old covers	Total	Control	Exposed scales	Scales settled under old covers	Total	Control	Exposed scales	Scales settled under old covers	Total	Control
			Per cent	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
1 [2]	Oil 1 [3]	2	40.5	10.1	16.3	8.6	59.0	24.8	30.3	21.2	52.5	36.5	38.0	24.6
2	do	4	93.9	68.1	73.9	71.5	75.2	48.1	51.6	45.2	60.5	66.1	67.2	60.1
3	do	6	98.4	84.5	87.0	85.8	90.4	72.8	75.9	72.7	87.5	88.9	88.8	86.4
4	Oil 2 [3]	2	63.5	17.2	26.0	19.2	72.6	26.6	34.7	26.1	60.4	45.1	45.9	34.2
5	do	4	91.1	67.5	72.2	69.6	95.6	72.9	76.5	73.4	73.0	58.6	59.5	50.7
6	do	6	100.0	87.1	89.3	88.3	98.5	74.8	80.7	78.2	95.3	89.7	90.1	88.0
7	Oil 6 [3]	2	68.2	9.0	21.8	14.6	68.2	21.1	29.3	20.0	54.4	27.7	29.5	14.2
8	do	4	88.3	33.0	45.6	40.6	90.2	63.8	60.6	55.4	87.1	72.3	73.2	67.4
9	do	6	96.3	77.6	81.7	80.0	97.7	77.6	83.6	81.4	92.3	86.2	86.5	83.6
10	Oil 1 [4]	2	46.3	10.8	18.8	11.4	58.5	26.1	29.9	20.7	50.0	33.8	35.2	21.2
11	do	4	96.6	78.5	83.4	81.9	97.1	78.0	81.9	79.5	67.4	50.3	51.1	40.5
12	do	6	96.9	92.4	93.0	92.4	99.1	97.7	98.0	97.7	88.8	87.3	87.4	84.7
13	Oil 2 [4]	2	45.0	10.7	17.9	10.4	68.0	26.9	35.4	26.9	53.2	28.6	30.5	15.4
14	do	4	95.8	75.6	78.5	76.5	95.3	79.1	81.8	79.4	90.6	79.4	80.1	75.8
15	do	6	100.0	94.3	94.9	94.4	90.4	86.5	87.4	85.7	94.4	87.3	87.8	85.2
16	Oil 6 [4]	2	46.6	9.6	18.3	10.8	47.8	14.5	20.7	10.3	52.6	32.9	34.8	20.7
17	do	4	91.9	72.7	69.2	66.4	92.5	81.7	83.4	81.2	69.0	57.5	58.5	49.5
18	do	6	99.2	88.9	90.2	89.3	100.0	93.2	94.1	93.3	94.6	88.7	89.2	86.9
19	Oil 7	1–15	92.9	65.6	69.1	66.3	65.0	29.7	39.1	31.1	41.2	38.0	38.3	24.9
20	Oil 4	1–15	93.8	56.5	63.6	60.3	74.8	36.8	45.1	37.9	73.2	73.0	73.0	67.2
21	Lime-sulphur	1–7	26.0	6.7	11.2	3.1	45.4	18.6	27.9	18.4	61.2	41.3	43.0	30.7
22	Unsprayed check		17.2	6.5	8.4		14.0	10.8	11.6		23.4	17.3	17.8	
23	Oil 7	1–15	27.7	10.3	14.1	9.7	46.4	15.3	23.0	17.0	46.5	41.4	42.6	29.4
24	Oil 6 [4]	4	77.3	44.0	50.2	47.6	58.6	22.6	31.6	26.3	73.1	57.1	61.6	52.8
25	do [3]	4	72.9	28.9	41.8	38.8	67.8	22.8	36.5	31.6	60.6	59.0	59.4	50.1
26	Unsprayed check		20.3	2.3	4.9		12.7	4.7	7.2		28.4	15.1	18.7	
27	Oil 6 [4]	6									96.1	97.4	97.2	96.6

[1] For characteristics of oils used, see table 6.
[2] Tests 1–22, inclusive, in orchard no. 1, the spray applied with a hand-pumped barrel sprayer. Tests 23–27 in orchard no. 2, the spray applied with a power sprayer.
[3] Emulsified according to formula no. 1 (p. 17).
[4] Emulsified according to formula no. 2 (p. 17).

In the tests reported in table 1 some injury resulted to the trees that were sprayed in the first orchard, this injury being confined for the most part to those tests in which the lubricating-oil emulsions were applied at the 6-percent dilution. It was most serious in the December application, less serious in the February application, and absent in the March–April application. There was no noticeable

difference in the degree of injury caused by the three oils that were used, each oil causing about the same injury at the 6-percent dilution. A few of the trees sprayed with the lubricating oils at the 4-percent dilution showed a few injured twigs (as evidenced by delayed bud opening), but in no case was the injury extensive or serious. Except from the 6-percent oil dilution in the December application, none of the injury was as much as would result from permitting a moderate or heavier infestation of the obscure scale to develop unimpeded. As the only really serious injury occurred as a result of the early December application, it was attributed to the fact that the trees had not become fully dormant, with the added possibility that the condition of the trees may have been partially responsible owing to the fact that they had suffered considerably from drought during the preceding summer and early fall with subsequent premature defoliation. The liquid lime-sulphur and the miscible oils caused no injury in the tests in which they were used.

Experiments were carried out during the dormant season of 1931–32 for the purpose of obtaining further information concerning the effect of oils of different physical characteristics on pecan trees and their effectiveness in controlling the obscure scale. The tests were applied with a power sprayer in a number of orchards offering varied conditions; some of the orchards were planted in bottom land, some in hill soil, some were intercropped, some were maintained in clean cultivation, some were healthy and vigorous, while others were growing under unfavorable conditions. Data showing the effectiveness of the materials used in these tests are given in tables 2 and 3, and data indicating their effect on the trees are given in table 4.

TABLE 2.—*Results of spraying experiments on the obscure scale on pecan trees, Shreveport, La., 1932*

[Approximately 1,000 scales were examined in each test except in check test no. 25, in which 2,000 were examined. Tests nos. 1–25, inclusive, were in one orchard and tests nos. 26–29, inclusive, were in a second orchard]

Test no.	Material used	Dilution [1]	Scales dead	Control obtained	Test no.	Material used	Dilution [1]	Scales dead	Control obtained
		Percent	*Percent*	*Percent*			*Percent*	*Percent*	*Percent*
1	Oil 17 [2 3]	4	77.05	68.7	16	Oil 6	5	90.10	86.5
2	do	5	97.36	96.4	17	do	6	92.70	90.0
3	do	6	98.54	98.0	18	Oil 18	4	81.32	74.5
4	do	8	95.87	94.4	19	do	5	87.04	82.3
5	Oil 14	4	83.67	77.7	20	do	6	97.83	97.0
6	do	5	85.70	80.5	21	Oil 19	4	58.10	42.8
7	do	6	96.37	95.0	22	do	5	83.10	76.9
8	Oil 16	4	86.25	81.2	23	do	6	91.70	88.7
9	do	5	97.78	97.0	24	do	8	98.46	97.9
10	do	6	97.90	97.1	25	Unsprayed check		26.75	
11	do	8	98.64	98.1	26	Oil 6	4	80.21	72.5
12	Oil 15	4	75.13	66.0	27	do	5	85.81	80.3
13	do	5	92.42	89.6	28	do	6	92.47	89.5
14	do	6	98.53	98.0	29	Unsprayed check		27.97	
15	Oil 6	4	63.97	50.8					

[1] Percentage oil in the dilute emulsion.
[2] For characteristics of oils used, see table 6, p. 18.
[3] All oils emulsified according to formula no. 2, p. 17.

TABLE 3.—*Average effectiveness of all oil dilutions used, as indicated by data in table 2, in spraying experiments on the obscure scale on pecan trees, Shreveport, La., 1932.*

Percentage of oil in spray	Tests	Average degree of control	Percentage of oil in spray	Tests	Average degree of control
	Number	*Percent*		*Number*	*Percent*
4	8	66.8	6	8	94.2
5	8	86.2	8	3	96.8

TABLE 4.—*Effect of oil sprays on dormant pecan trees, Shreveport, La., 1932*

Oil no.	Dilution used	Effect of oils on trees to which applied			
		Bottom-land orchards		Hill-land orchards	
		Planted in alfalfa, soil fertile, twig growth moderate, foliage good until affected by drought late in fall 1931; trees as a whole moderately vigorous. Sprayed Feb. 29	Tree rows clean cultivated, soil fertilized, twig growth strong, foliage excellent; trees unusually vigorous. Sprayed Mar. 2	Cropped with cotton, soil poor, twig growth light to moderate, foliage fair until affected by drought early in fall of 1931; trees fairly vigorous. Sprayed Feb. 12	Clean cultivation in summer, winter cover crop planted but died out, soil poor, eroded, twig growth light, foliage poor; trees lacking in vigor. Sprayed Feb. 24
	Percent				
17	4	None		None	
	5	do		Trace	
	6	do		None	
14	4	do		do	
	5	do		do	
	6	do		do	
16	4	do		do	Light, twig tips injured.
	5	Trace		do	
	6	do		Light, 2 small limbs seriously injured.	Moderate, 4–5 small-medium limbs killed.
	8				Severe, 30–40 percent limbs killed.
	12				Severe, 50–60 percent limbs killed
15	4	None		None	Light, 3–4 small limbs hurt.
	5	do		do	
	6	Trace		Trace	Moderate, 4–5 small-medium limbs killed.
	8				About same as 6 percent dilution.
	12				Severe, about 70 percent limbs injured.
6	4	None	None	None	
	5	Trace	do	do	
	6	None	do	Trace	
18	4	do		None	Trace, a few twig tips hurt.
	5	do		do	
	6	Light, 2–3 small limbs killed.		Moderate, considerable weak sickly foliage.	Light, 2–3 small limbs made weak growth.
	8				Light, retarded bud opening, 1 medium sized limb killed.
	12				Severe, 50–60 percent of tree seriously injured.
19	4	None		None	Light, twig tips injured, 1 small limb made poor growth.
	5	do		do	
	6	Trace		do	Moderate, some dead twig tips, 4–5 small limbs killed.
	8				Severe, 20 percent of tree seriously injured.
	12				Severe, 50–60 percent of tree seriously injured.

The data in tables 2 and 3 indicate that it is an extremely difficult task to obtain a 100 percent kill of the obscure scale, three tests in which 8 percent lubricating-oil emulsions were used failing to give such a kill. At the same time, these and other tests (table 4) showed this strength of oil unsafe for application to dormant pecan trees. The data furnish, to a large degree, the answer to the problem as to

what dilution of oil will give the best control with a reasonable degree of safety to the trees.

As in previous tests, 4 percent oil sprays gave a good control of the scales developing unprotected by old scale covers whereas they gave only a fair degree of control of those beneath the old covers. At the same time they did not injure dormant pecan trees in the tests in which they were used. Sprays containing 5 percent of oil, not previously tested, gave a decided increase in the percentage of control (table 3) over those containing 4 percent, but they were slightly more dangerous to use (table 4), indicating that they should not be recommended for use without some reservations. As in previous tests, sprays containing 6 percent of oil gave a reasonably satisfactory control of both light and heavily encrusted infestations and proved the most satisfactory ones to use from the standpoint of control obtained, but, as in the previous year, they caused no injury in some and serious injury in other instances. For this reason, this strength cannot be recommended for use. It should be noted that oils of very low viscosity (oils 14 and 17, table 6) were practically as effective as those of higher viscosity and caused less injury (table 4) to the trees in the orchards in which they were tested. It is desirable that these oils be tested further before they are recommended for general use. With the exception of oil 19, which gave somewhat lower results than other oils, there were no consistent differences in the percentage of control given by the oils used in tests reported on in table 2. This indicates that, in general, oils having the physical characteristics of those usually recommended for use in dormant oil sprays will prove to be about equally satisfactory from the standpoint of scale control, with the added possibility, as previously mentioned, that oils lower in viscosity and higher in volatility (oils 14 and 17, table 6) may prove effective and safer.

The data in table 4 indicate that pecan trees are unable to withstand as strong concentrations of oil sprays as are many other deciduous trees. The injury which in some cases did result did not vary in degree according to the viscosity, volatility, or unsulphonated residue of the oils used, although some oils (16 and 18) appeared slightly more likely to cause injury than others. Also, oils which caused injury in one orchard were used with perfect safety in others, and vice versa. Therefore it seems likely that some condition or factor other than the oils limits or controls the quantity of oils that pecan trees are able to stand without suffering injury. Tests not listed in table 4, in which oils 15 and 16 were applied to young, vigorous trees on the laboratory grounds at dilutions as high as 25 percent of oil, showed that no injury resulted when the applications were made during the strictly dormant period and but little injury when they were made at the delayed-dormant period. In other tests, oils 18 and 19 caused no injury when applied at a dilution containing 3 percent of oil during the dormant period, but when they were applied at the delayed-dormant period they caused injury in some, but not all, instances to the extent of setting back bud opening and development for 4 or 5 days. This setback was soon overcome and apparently no permanent injury resulted. Even so, it is evident that the application of dormant types and strengths of oil sprays should be confined to the strictly dormant period.

From observations made by the writer it would appear that one factor more than all others likely to determine whether injury will result from the application of dormant oil sprays to pecan trees is the physical condition of the trees themselves. Strong, healthy, vigorous trees enjoying the benefits of good soil, cultivation, fertilization, moisture, and healthy foliage apparently withstand heavier dosages of oil sprays than trees growing in poor, unfertile, uncultivated, unfertilized, or eroded soil and suffering from drought or premature defoliation.

SUMMER SPRAY APPLICATIONS

In addition to the attempts that have been made to secure control of the obscure scale by means of dormant spray applications, additional efforts have been made to limit its spread and development by the use of summer applications of oil sprays.

During the emergence period of the crawlers in 1931 and again during the same period of 1932, tests were made to determine whether the application of oil sprays to the trees would prevent or deter the crawlers from settling, or, permitting them to settle, perhaps prevent or interfere with their normal development.

In 1931, oils 1, 6, 11, 12, and 13 (table 6) were emulsified according to formula no. 2, page 17, and applied to good-sized limbs on orchard trees at dilutions of 0.5, 1, and 2 percent of oil by means of a compressed-air sprayer. Oils 8, 9, and 10, commercially prepared summer oils, were applied in the same manner at dilutions of 1 and 2 percent of oil. At regular intervals twigs were cut from the sprayed limbs and taken to the laboratory, and crawlers were transferred to them as long as the oil seemed to affect the settling of the crawlers. The high-viscosity low-volatility oils exerted the more pronounced and most lasting influence on the settling of the crawlers, the degree of and duration of the influence being directly proportional to the strength of oil used. The dormant-type oils caused foliage injury when used at dilutions exerting any pronounced deterring influence on the settling of the crawlers. The summer oils caused no injury. Oil 9 at 2-percent and oil 10 at 1-percent dilution exerted a pronounced deterring influence on the settling of crawlers for a 3-day period, while oil 10 at 2 percent exerted a strong influence over a period of 2 weeks.

In 1932, oils 8, 9, 10, and 20 were used in similar tests, except that potted trees were sprayed instead of orchard trees. Oil 20 was emulsified according to formula no. 2 (p. 17). Two trees were sprayed with each oil at dilutions of 1 and 2 percent of oil, respectively, in the diluted emulsion. Crawlers were transferred to them at regular intervals as long as any of the oils appeared to be exerting any influence on the settling of the insects. Oils 8, 9, and 10 showed no deterring influence after the third day whereas oil 20, much lower in volatility than any of the others, exerted a considerable influence at both the 1- and 2-percent dilutions for 2 weeks and some influence at 2 percent for a slightly longer period. About 1 month after the final transfer of crawlers those specimens successfully settled on the oil-sprayed potted trees appeared to be developing just as normally and successfully as those settled on unsprayed check trees.

The spraying of pecan trees infested with the obscure scale during the crawler-emergence period to kill the crawlers or prevent their settling is not deemed practical, for the following reasons: (1) The

long period during which crawlers are present, (2) the relatively short period that any of the oils tested were effective in deterring crawlers from settling, (3) the comparatively high cost of oils of an effective and safe type, (4) the fact that those crawlers eventually settling are able to develop as normally and successfully as if on unsprayed surfaces, (5) the difficulty of obtaining a thorough covering of infested trees, and (6) because the cost of the treatment would be out of all proportion to the benefit resulting.

As the writer believed that the newly settled scales might be more readily killed than older, larger ones, oil sprays were applied to heavily infested branches by means of a hand-operated compressed-air sprayer in the summer of 1931 after the height of crawler emergence and settling had passed. These tests and the results effected by them are given in table 5.

TABLE 5.—*Effect of oil sprays on newly settled young of the obscure scale on pecan trees, Shreveport, La., 1931*

Test no.	Oil used[1]	Oil content	Scales settled		Scales dead		Total dead	Control	Effect on foliage
			Protected	Exposed	Protected	Exposed			
		Percent	*Number*	*Number*	*Percent*	*Percent*	*Percent*	*Percent*	
1	8[2]	1.0	676	325	21.89	34.15	25.87	Minus	None.
2	do	2.0	622	386	26.05	49.74	35.12	10.6	None.
3	9	1.0	631	369	23.93	48.78	33.10	7.8	None.
4	do	2.0	625	381	26.24	51.71	35.88	11.7	None.
5	10	1.0	729	272	22.91	52.57	30.97	4.9	None.
6	do	2.0	758	242	34.43	71.07	43.30	21.9	None.
7	11[3]	.5	687	313	25.47	45.69	31.80	6.1	None.
8	do	1.0	835	175	21.20	37.14	23.96	Minus	None.
9	do	2.0	787	219	37.48	71.69	44.93	24.1	Small amount.
10	12	.5	722	281	28.67	55.16	36.09	12.0	None.
11	do	1.0	806	227	29.16	76.65	39.59	16.8	None.
12	do	2.0	791	209	54.61	99.04	63.90	50.3	Small amount.
13	13	.5	659	341	24.89	52.20	34.20	9.4	None.
14	do	1.0	788	214	23.22	56.07	30.24	3.9	None.
15	do	2.0	844	162	48.58	92.59	55.67	38.9	Small amount.
16	Unsprayed check	----	750	250	21.73	44.40	27.40	----	

[1] For physical characteristics of oils used, see table 6, p. 18.
[2] Oils 8, 9, and 10 were commercially prepared summer oils.
[3] Oils 11, 12, and 13 were emulsified according to formula no. 2, p. 17.

None of the tests shown in table 5 gave any worth-while control, test 12 giving the best, namely 50.28 percent. As with the dormant-spray applications, better control was effected of the exposed scales than of those developing beneath old covers. This again indicates the inability of oil sprays of low dilutions to penetrate these old scale covers sufficiently to effect a high kill. In addition, those oils giving the best control showed a tendency to cause some injury to the foliage, indicating that they could not be applied to the trees with any wide margin of safety.

RECOMMENDATIONS FOR CONTROL

As a result of the data presented in tables 1 to 5, inclusive, together with supporting data, the following recommendations for effecting control of the obscure scale on pecan trees are presented: (1) If the infestation is light (not heavily encrusted), use a 4-percent lubricating-oil emulsion regardless of the physical condition of the trees. (2) If the infestation is heavy, use a 4-percent lubricating-oil emulsion

if the trees are in poor physical condition and a 5-percent emulsion if the trees are in otherwise good physical condition. (3) Make all applications during the strictly dormant period, but preferably not until after the first of January, in order to give the trees plenty of time in which to become dormant. (4) Apply the spray to all portions of heavily infested small to moderate sized trees and to the lower three fourths of all other trees, making sure that the application to the parts sprayed is thorough, remembering that the scale specimens must be hit by the spray to be killed by it, but do not drench the parts sprayed beyond the point necessary to obtain a complete coverage. (5) Use any oil within the range of the physical characteristics usually recommended for use in dormant oil sprays. The usual oils appear to be about equally effective and to offer about the same margin of safety to the trees, with the added, though not yet thoroughly tested, possibility that oils lower in viscosity and higher in volatility than those generally recommended may prove effective at strong dilutions and give a wider margin of safety to the trees.

FORMULAS USED IN PREPARING LUBRICATING-OIL EMULSIONS

The formulas used in preparing the lubricating-oil emulsions employed in the tests reported upon in this circular are given below. For more complete information regarding the preparation and use of oil sprays, the reader is referred to Farmers' Bulletin 1676 (*8*).

No. 1.—Lubricating-oil emulsion (soap emulsifier). Made according to the standard Government formula (1)

Oil	2 gallons.
Water	1 gallon.
Potash-fish-oil soap	2 pounds.

These materials are heated in a suitable container until the soap is dissolved and the mixture comes to a boil. The mixture is then immediately pumped twice with a bucket pump, or other suitable pump, about 60 pounds' pressure being used.

No. 2.—Lubricating-oil emulsion (soap emulsifier). Made according to the cold-stirred rosin-fish-oil soap formula [8]

Oil	9 gallons (about 65 pounds).
Rosin-fish-oil soap	1 gallon (about 8 pounds).

Pour the soap into a suitable container, then add a quantity of oil, not more than one third of the volume of the soap. Stir the oil rapidly into the soap until all the oil has disappeared and the mixture is somewhat stiff. Continue to add successive quantities of oil to the resulting mixture in an increasing quantity each time but never more than one third of the total bulk of the mixture, and never adding oil until that previously added has been thoroughly stirred into the soap. Continue this procedure until all the oil has been stirred in. Any free oil found on the surface of the stock emulsion can, and should, be stirred into the mixture before it is used.

SPECIFICATIONS OF OILS USED

The specifications of the oils used in these experiments are given in table 6.

[8] SIEGLER, E. H., and BROWN, L. DIRECTIONS FOR MAKING A COLD-STIRRED LUBRICATING-OIL EMULSION USING ROSIN-FISH-OIL SOAP AS THE EMULSIFIER. U.S.Dept.Agr., Bur. Ent. Circ. E-277, 5 p., illus. 1930. [Mimeographed.]

TABLE 6.—*Physical specifications*[1] *of oils used in spraying experiments for the obscure scale, Shreveport, La.*

Oil no.	Viscosity (Saybolt at 100° F.)	Volatility (4 hours at 105–110° C.)[2]	Unsulphonated residue	Oil no.	Viscosity (Saybolt at 100° F.)	Volatility (4 hours at 105–110° C.)[2]	Unsulphonated residue
	Seconds	*Percent*	*Percent*		*Seconds*	*Percent*	*Percent*
1	85	1.20	64	11	54	34.60	69.5
2	145	12.01	0	12	106	8.70	67.8
3	228	.10	60	13	223	9.10	60.3
4[3]	[4] 348	3.91	50	14	55	36.40	70
5	100	.28	48	15	100	13.80	61
6	207	.92	19	16	105	.72	69
7	170	5.26	50	17	55	13.76	78
8[5]	53	31.90	87.6	18	215	5.70	57
9	70	31.80	88	19	230	3.80	63
10	109	12.90	93.8	20	86	2.20	96

[1] All analyses made by U.S. Bureau of Chemistry and Soils.
[2] Volatility of oils 1–13, inclusive, obtained for 4 hours at 105° C. and remainder for 4 hours at 110° C.
[3] Oils 4, 5, and 7 were commercially prepared miscible oils, 5 and 7 being different lots of the same brand.
[4] At 140° F.
[5] Oils 8, 9, and 10 were commercially prepared summer oils.

SUMMARY

The obscure scale is an important pest of all varieties of pecans throughout a large portion of the pecan belt. It attacks all parts of the tree proper, developing first on the lower, inner portions of the trees and spreading gradually outward and upward. Limbs up to 3 inches in diameter are most frequently killed by its attacks. The greatest injury results from the gradual killing of branches and the weakening of infested trees, which renders them more subject to attack by borers, other insects, and diseases.

Eggs are first extruded between the middle of May and early in June, and crawlers can be found a few days later. Both eggs and crawlers are present in large numbers throughout June and until the middle of July, after which they gradually decrease in numbers until by the first of August only a few remain.

The first crawlers settle under old scale covers, and those that emerge from beneath the cover of the parent scale settle within a short time and usually not far away. They gradually increase in size, and their covers assume the color of the surface on which they are resting.

Most of the winter is passed by the male scale in the second larval stage and by the female in the stage preparatory to the second molt. Development is resumed late in the winter, and most specimens reach the adult stage by the middle of April, adult males emerging as the females are completing the final molt. Mating takes place at once and eggs are soon formed. There is but a single generation each year.

Parasites, predators, and diseases exert a considerable influence in reducing the numbers of this scale, and in some instances appear to hold infestations in check without the aid of artificial control measures, though artificial control is usually necessary.

Four-percent lubricating-oil emulsions have given good control of light infestations of the obscure scale and of those scales not protected by old scale covers, and have proved safe when used during the strictly dormant period. Five-percent emulsions have given an increased degree of control but have shown a slightly greater tendency to cause injury. Six-percent emulsions have given a satisfactory, but not perfect, control of the heaviest infestations but have caused serious injury in some of the tests in which they have been used. Eight-percent emulsions gave excellent control but caused serious injury.

Miscible oils, 1 part stock solution to 15 parts water, proved slightly less effective than 4-percent lubricating-oil emulsions. Liquid lime-sulphur was ineffective at dilutions as strong as 1 part stock solution to 5 parts water.

Applications at any time (early, middle, or late) in the dormant season of the tree were about equally effective.

The method by which the several oils used were emulsified did not appear to affect the degree of control produced by them.

There were no appreciable differences in the degree of control effected by the several oils used in the form of lubricating-oil emulsions in the tests reported upon, indicating that any oil coming within the limits of the specifications generally recommended for use in dormant oil sprays should be satisfactory under most conditions. Limited tests of oils somewhat lower in viscosity and higher in volatility than those ordinarily recommended seemed to show them to be nearly as effective as other oils and slightly less injurious to the trees.

Applications of spray unusually early in the dormant period of the tree and at the delayed-dormant period were more likely to result in injury than strictly dormant applications.

Any lack of vigor in the trees sprayed, or results of drought or neglect, appeared to influence injury from the spray applications more than any characteristic of the oil used in the spray.

The spraying of pecan trees with oil sprays just before the crawlers emerged did not result in any lasting deterrent effect on crawler settling, and specimens that did settle on the oil-sprayed trees developed just as normally and successfully as those that settled on unsprayed trees.

Thorough application to all parts of heavily infested small to moderate sized trees and to the lower three fourths of all other trees during the strictly dormant period, but not before January, of lubricating-oil emulsions at 4 or 5 percent oil content, according to the physical condition of the trees, is the recommended control measure.

LITERATURE CITED

(1) Ackerman, A. J.
1923. preliminary report on control of san jose scale with lubricating-oil emulsion. U.S. Dept. Agr. Circ. 263, 18 p., illus.

(2) Comstock, J. H.
1881. report of the entomologist. U.S. Dept. Agr. Ann. Rpt. Commr. 1880: 235–373, illus.

(3) Dozier, H. L.
1924. the obscure scale attacking pecan trees. Gulf Coast Grower 2 (4): 2, 5, 7, illus.

(4) Hammer, A. L.
1926. brief summary report. . . Miss. Agr. Expt. Sta. Rpt. 39: 18–19.

(5) Harned, R. W.
1925. annual report of the department of zoology and entomology. Miss. Agr. Expt. Sta. Rpt. 38: 26–31.

(6) Herrick, G. W., and Harned, R. W.
1909. notes on additional insects on cultivated pecans. Jour. Econ. Ent. 2: 293–295.

(7) Houser, J. S.
1918. destructive insects affecting ohio shade and forest trees. Ohio Agr. Expt. Sta. Bull. 332, p. 165–487, illus.

(8) Quaintance, A. L., Newcomer, E. J., and Porter, B. A.
1931. lubricating-oil sprays for use on dormant fruit trees. U.S. Dept. Agr. Farmers' Bul. 1676, 18 p., illus.

(9) Woodard, J. S.
1924. pecan insects. Tex. Dept. Agr. Bul. 77: 125–142, illus.

ORGANIZATION OF THE UNITED STATES DEPARTMENT OF AGRICULTURE WHEN THIS PUBLICATION WAS LAST PRINTED

Secretary of Agriculture	HENRY A. WALLACE.
Assistant Secretary	REXFORD G. TUGWELL.
Director of Scientific Work	A. F. WOODS.
Director of Extension Work	C. W. WARBURTON.
Director of Personnel and Business Administration.	W. W. STOCKBERGER.
Director of Information	M. S. EISENHOWER.
Solicitor	SETH THOMAS.
Bureau of Agricultural Economics	NILS A. OLSEN, *Chief.*
Bureau of Agricultural Engineering	S. H. MCCRORY, *Chief.*
Bureau of Animal Industry	JOHN R. MOHLER, *Chief.*
Bureau of Biological Survey	PAUL G. REDINGTON, *Chief.*
Bureau of Chemistry and Soils	H. G. KNIGHT, *Chief.*
Office of Cooperative Extension Work	C. B. SMITH, *Chief.*
Bureau of Dairy Industry	O. E. REED, *Chief.*
Bureau of Entomology	LEE A. STRONG, *Chief.*
Office of Experiment Stations	JAMES T. JARDINE, *Chief.*
Food and Drug Administration	WALTER G. CAMPBELL, *Chief.*
Forest Service	FERDINAND A. SILCOX, *Chief.*
Grain Futures Administration	J. W. T. DUVEL, *Chief.*
Bureau of Home Economics	LOUISE STANLEY, *Chief.*
Library	CLARIBEL R. BARNETT, *Librarian.*
Bureau of Plant Industry	WILLIAM A. TAYLOR, *Chief.*
Bureau of Plant Quarantine	AVERY S. HOYT, *Acting Chief.*
Bureau of Public Roads	THOMAS H. MACDONALD, *Chief.*
Weather Bureau	CHARLES F. MARVIN, *Chief.*

Agricultural Adjustment Administration	GEORGE N. PEEK, *Administrator.* CHARLES J. BRAND, *Coadministrator.*

This circular is a contribution from

Bureau of Entomology	LEE A. STRONG, *Chief.*
Division of Fruit and Shade Tree Insects	D. L. VAN DINE, *Principal Entomologist, in Charge.*

U. S. GOVERNMENT PRINTING OFFICE: 1933

For sale by the Superintendent of Documents, Washington, D.C. - - - - - - Price 5 cents